Ontario

Ministry of the
Environment

GUIDANCE DOCUMENT

DEVELOPMENT OF MICROBIAL CONTAMINATION CONTROL PLANS

(*Interim Wellhead Protection Measures Plan*)

FOR MUNICIPAL GROUNDWATER SUPPLY WELLS UNDER DIRECT INFLUENCE OF SURFACE WATER WITH EFFECTIVE IN-SITU FILTRATION

Date: January 2004

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I. PURPOSE

The purpose of this Guidance Document is to help municipalities develop plans for implementation of measures to protect the sources of their groundwater supplies from microbial contamination. Development and implementation of microbial contamination control plans, subject to approval by the Ministry of the Environment, is required for municipal drinking-water systems using groundwater under the direct influence of surface water (GUDI) with effective *in situ* filtration where the municipality chooses not to provide chemically assisted filtration, or approved equivalent treatment, ahead of disinfection.

The focus of microbial contamination control plans is the implementation of measures to minimize aquifer disturbance and microbial contaminant loadings to the aquifer in close proximity to GUDI wells relying on *in situ* filtration for the removal of suspended particulate matter. Particulate matter could harbour large numbers of microbes and interfere with the disinfection process.

Since this particulate matter removal through *in situ* filtration would otherwise be achieved through an engineered chemically assisted filtration process, the *in situ* filtration is considered an integral part of the water treatment process. For the same reason, the requirement for the implementation of measures intended to preserve integrity of the aquifer's overburden in the vicinity of the wellhead and minimize microbial contaminant loading to the aquifer are considered to be water treatment related requirements.

If required, these wellhead protection microbial contamination control measures, may become the first step in the implementation of a long-term source water protection plan. The Ministry of the Environment is currently considering a province wide program of source water protection. At some point in time, all municipalities may be required to develop and implement comprehensive wellhead protection plans addressing all potential sources of contamination (not only microbial contamination). These comprehensive plans would extend beyond the immediate zone of influence on the wellheads to which these wellhead protection microbial contamination control measures apply. For this reason, these microbial contamination control measures have been referred to as interim wellhead protection measures.

This document must be used in conjunction with "***Terms of Reference for Hydrogeological Study to Examine Groundwater Sources Potentially under the Direct Influence of Surface Water***" ("GUDI Terms of Reference"), and "***Protocol for Delineation of Wellhead Protection Areas For Municipal Groundwater Supply Wells under Direct Influence of Surface Water***" ("Delineation Protocol"). These documents contain direction and details with regard to steps that need to be followed before preparation of microbial protection plans.

II. APPLICABILITY

This Guidance Document specifically applies to municipal groundwater supply systems where the delineation of wellhead protection areas and a proposal for implementation of wellhead protection measures is a requirement of a consolidated Certificate of Approval for the water works issued by the Ministry on the basis of the review of the Engineer's Report submitted in accordance with the Drinking Water Protection Regulation (O.Reg. 459/00).

Under the consolidated Certificate of Approval process, hydrogeological studies were required for all municipal wells which had been determined to be potentially under the direct influence of surface water. These studies had to be conducted in accordance with the Ministry document "***Terms of Reference for Hydrogeological Study to Examine Groundwater Sources Potentially under the Direct Influence of Surface Water***" (GUDI Terms of Reference).

As explained in the GUDI Terms of Reference, where such a hydrogeological study has concluded that the groundwater source is under the direct influence of surface waters and that the aquifer is providing effective *in situ* filtration, the owner is required to:

- provide chemically assisted filtration (or equivalent) followed by disinfection; or

- (1) provide enhanced disinfection, (2) delineate wellhead protection areas in accordance with the Ministry document ***"Protocol for Delineation of Wellhead Protection Areas for Municipal Groundwater Supply Wells under Direct Influence of Surface Water"***, and (3) develop and submit for Ministry approval a proposal for implementation of adequate wellhead protection measures to ensure continued effectiveness of the *in situ* filtration processes.

A microbial contamination control plan developed by a municipality in accordance with this Guidance Document and submitted to the Ministry will satisfy conditions of a Certificate of Approval that requires submission of a plan for implementation of wellhead protection measures related to a GUDI system with adequate *in situ* filtration. Based on this submission, the Certificate of Approval would be amended to include requirements regarding implementation of the plan.

Unless specifically required otherwise by conditions of a future Certificate of Approval, this Guidance Document will also apply to a proposal for implementation of an *in situ* filtration related wellhead protection measures that may be required to be submitted under conditions of a subsequently issued Certificate of Approval for a drinking-water system under the new Safe Drinking Water Act and in accordance with the new Drinking-Water Systems Regulation (O.Reg 170/03) under the Safe Drinking Water Act.

III. DEVELOPMENT OF A MICROBIAL CONTAMINATION CONTROL PLAN

In accordance with the "***Terms of Reference for Hydrogeological Study to Examine Groundwater Sources Potentially under the Direct Influence of Surface Water***" ("GUDI Terms of Reference"), in order for a well to be characterized as having "effective *in situ* filtration", the following conditions must be met:

a) Particle count data must show that the water consistently contains significantly less than 100 particles per mL in the size range 10 microns and greater in size. Particle counts must remain constantly low during storm, season or other regular environmental changes. This is required to ensure that embedded microbes are not shielded from effective UV or chlorine disinfection.

b) The raw water does not contain significant microbial loadings. This is required to ensure that the disinfection processes are not overwhelmed by microbial loadings.

The microbial contamination control plan must, therefore, address both particle counts and microbial loadings. To do this, the plan must:

1. Delineate microbial risk management zones.
2. Inventory and rank the risk of existing and potential activities that might affect the *in situ* filtration capability of the aquifer.
3. Inventory and rank the risk of existing and potential sources of microbial contamination.
4. Identify measures to protect well(s) from microbial contamination and to protect the *in situ* filtration capability of the aquifer.
5. Develop appropriate monitoring and contingency plans.
6. Establish a schedule for implementation of the microbial contamination control measures.

The following sections of this part of the Guidance Document provide detailed recommendations regarding the above list of required elements/steps of a microbial contamination control plan intended to be submitted to the Ministry in support of a proposal not to include a chemically assisted filtration step in the water treatment system using groundwater under direct influence of surface water.

For additional information and suggestions, the municipality developing such a microbial contamination control plan may also refer to the **"Reference Document - Model Microbial Contamination Plan for Municipal Groundwater Supply Wells under Direct Influence of Surface Water with Effective *in situ* Filtration".**

1. Delineation of Microbial Risk Management Zones

Time of travel zones must be delineated for each municipal well and well-field to which the requirement applies. The delineation must be completed in accordance with the Ministry document ***"Protocol for Delineation of Wellhead Protection Areas For Municipal Groundwater Supply Wells under Direct Influence of Surface Water"*** ("Delineation Protocol").

Based on the explanations provided in the delineation protocol, for the purpose of developing the microbial contamination control plan, the focus should be on the identifying the following two saturated horizontal time of travel (TOT) zones:
1) 0 to 50 days
2) 50 days to 2 years

In accordance with the Delineation Protocol, three-dimensional, steady-state computer models (such as MODFLOW) should be used to delineate capture zones unless site-specific conditions suggest that other methods described in the Delineation Protocol are more appropriate. For example, where limited hydrogeological data are available and the well is in a remote sand plain, simpler methods utilizing conservative assumptions may be adequate.

In assessing potential microbial risks, consideration can be given to groundwater intrinsic susceptibility (GwIS). Intrinsic susceptibility is the time it takes for water to move from ground surface down into the upper water bearing zone supplying the well. For example, 20 metres of silt over a confined aquifer would have a low intrinsic susceptibility whereas 10 metres of clean coarse sand or fractured rock would have a high susceptibility to contamination because it provides faster travel times and less retardation. Key attributes are the depth to upper water bearing zone and the conductivity of overlying geologic material. Where there is uncertainty regarding aquifer depth, the water table should be used.

2. Protection of *In Situ* Filtration Effectiveness of the Aquifer

To ensure the continued effectiveness of disinfection processes, particle counts must remain constantly low. Land use activities in the vicinity of a communal well whose water treatment process relies on the presence of effective in-situ filtration instead of a chemically assisted filtration (or equivalent)ahead of disinfection must, therefore, be controlled to ensure that the aquifer is not disturbed. Any nearby land uses causing significant ground vibration or which involve subsurface excavation, drilling or boring could potentially disturb the integrity of the aquifer and result in elevated particle counts in the well water.

3. Assessment of Microbial Contamination Risks

Contaminant inventories typically identify locations where activities are releasing or have the potential to release one or more contaminants into groundwater at a concentration of concern. Since this microbial contamination control plan is intended to ensure effective wellhead protection against potentially pathogenic microbial contaminants, it is appropriate to focus this contaminant inventory on the known and potential sources of pathogenic microbial contamination only (pathogenic viruses, bacteria, and protozoa).

In general, more stringent risk management measures such as property acquisition, planning and regulatory controls and verification through groundwater monitoring programs are used within the 50-day TOT zone.

3.1 Inventory of Microbial Contaminant Sources

3.1.1 Scope of the inventory: Since the risk of pathogenic microbial contamination of wells is normally limited to contaminant sources located in proximity, it is acceptable to focus this inventory on sources of pathogenic microbial contamination located within the 0 to 2-year TOT zones. However, high risk sources of microbial contaminants (such as communal sewage lagoons and livestock yards) should be identified even if they are beyond the 2-year TOT. All zones up to 25 year TOT are supposed to have been delineated in accordance with the Delineation Protocol.

3.1.2 Sources of potential microbial contamination: The inventory must include all sites/locations where there are existing and potential sources of pathogenic microbial contamination:

- Commercial/Industrial sources include activities such as graveyards, meat processing/packing plants, wastewater treatment/disposal facilities, areas of land application of wastewater treatment effluent/sludge etc.
- Agricultural/Rural sources include activities such as confined animal feeding operations, manure storage pits/liquid waste lagoons, manure spreading areas, sewage biosolids and other biosolids spreading areas, veterinary services, grazing lands, wildlife feeding/migration areas, aquaculture operations (fish farming), rural homesteads, campgrounds and trailer parks, stormwater surface runoff swales, ditches and ponds, waste disposal landfills and dumps etc.
- Residential/Municipal sources include housing developments, apartment/condominium buildings, campgrounds and trailer parks, sewage treatment/disposal facilities, septic systems and sewer lines, stormwater infiltration basins, wells and galleries, waste disposal landfills and dumps, unsealed abandoned wells and test holes etc.

3.1.3 Contents of the inventory of contamination sources: Information on each of the identified existing and potential sources of contamination should be compiled in a list including:

a) description of the contamination source:

- source name (if applicable), and name of owner/operator
- indication if it is an existing or potential source
- type of the source (see Section 3.1.2)
- approximate areal size of the source
- permanent/intermittent

b) location of the source:

- address (if applicable)
- geo-reference information based on NAD83 (North American Datum 1983). Field-based GPS coordinates are mandatory for major potential contaminant sources in high risk areas; desktop analysis may be sufficient in low risk areas.
- approximate saturated horizontal TOT to the well/well field
- linear distance to the well/well field
- current municipal land use zoning and land use designation for the location
- current land use
- source risk rank or category (see below)

In addition to the inventory list, all identified existing and potential sources of microbial contamination must be accurately plotted and identified (existing/potential, name and type) on a copy of the to-scale TOT delineation map prepared in accordance with the Delineation Protocol. This copy of the TOT delineation map must also identify the current municipal zoning and land use designations.

3.1.4 Risk Ranking/Categorization of the Contaminant Sources: Any identified source of microbial contamination within the delineated time of travel zones can pose a risk of contamination and possible loss of the water supply. Due to limited resources, however, it may be necessary for the municipality to focus efforts on the sources which pose the most significant risks.

In order to establish priorities for the plan of implementation of microbial contamination control measures, it is necessary to evaluate the relative degree of risk that the individual contamination sources identified in the inventory pose to the water supply. For this purpose, each identified contamination source must be ranked based on the relative degree of susceptibility of the water supply to contamination from the particular contamination source, and the likelihood that the source will release contaminants.

In such a risk ranking/categorisation, the individual source's risk (R) rank/category would be the product of the water supply's degree of susceptibility (S) to contamination from the source and the contamination source's degree of hazard (H), that is, the likelihood that the source will release contaminants. This relationship can be stated as an equation: SxH=R.

The likelihood that the potential contamination source will release significant amount of contaminants (the source's degree of hazard [H]), e.g., low, moderate or high, will depend on factors such as the amounts of contaminants generated by the source (size of the source), and the existence and the level of any groundwater protection measures such as the use of best management practices (BMPs) and monitoring of groundwater quality down-gradient from the source.

4. Microbial Contamination Control Measures

Microbial Contamination Control Measures must include the following components:
1) identification of potential risks,
2) recommendations to reduce/manage the risk of contaminant release to groundwater, and
3) recommendations for control of new development and specific activities within the area.

Although some of the microbial contamination management tools identified here refer to regulatory programs, it is generally accepted that groundwater protection within specific time of travel zones of the microbial contamination control areas can be accomplished most effectively and at the least cost by developing partnerships with local business, industry and the agricultural community, and focussing on educational/training and pollution prevention or best management practices concepts.

Since groundwater quality can be affected by a wide variety of human activities and sources, a comprehensive groundwater protection control program would incorporate various types of measures. These various microbial contamination control measures may be categorized into three general areas:
- pollution prevention/best management practices (BMPs),
- regulatory permitting/environmental assessment, and
- land use controls or restrictions.

4.1 Pollution Prevention/Best Management Practices: Pollution prevention is the use of materials, processes, or practices that reduce or eliminate the creation of pollutants or wastes at the source. The term Best Management Practices (BMPs) is generally used to describe operational practices, such as good housekeeping and spill prevention, or source control practices, such as designing a storm water system that prevents rapid infiltration in the water supply aquifer. Encouragement of implementation of BMPs through free technical assistance or training may be one very effective tool for local governments to use in reducing the risks of groundwater contamination in designated time of travel zones. Efforts at the local level to recognize businesses that employ environmentally sound practices and encourage consumers to support those businesses contributes significantly to the success of this program.

4.2 Regulatory Permitting/Approvals and Environmental Assessment: These measures are implemented through provincial laws, local by-laws and planning requirements. Technical standards are generally used to establish and ensure compliance with permitted discharges. These laws and requirements can affect the siting, design, construction, operation, and closure of facilities such as buildings, above and underground storage tanks, treatment plants, landfills, and transportation corridors.

In Ontario these laws include the Environmental Assessment Act, Environmental Protection Act, Ontario Water Resources Act, including the Drinking Water Protection Regulation (O.Reg 459/00) and the Water Wells Regulation (O.Reg 903 amended to O.Reg 128/03), and the Safe Drinking Water Act, including the Drinking-Water Systems Regulation (O.Reg 170/03) administered by the Province, as well as the Drainage Act and the Building Code Act (including the Plumbing Code) administered by the local governments.

One of the tools available to local government in managing potential contamination sources within specific time of travel zones of the microbial contamination control areas is the review and/or inspection of locally regulated/permitted facilities for adequacy and compliance with permit requirements. Such inspections may also serve to verify that any provincially approved/permitted operations associated with those facilities have valid approvals or permits.

4.3 Land Use Controls or Restrictions: An opportunity for promotion of microbial contamination prevention plans is through a municipality's Official Plan and Zoning By-laws. This approach notifies everyone with an interest in specific land uses and land use proposals that there are ground water contamination concerns. In addition, an Official Plan can contain schedules which map out well head protection zones for lands currently developed and for

those which have not yet been developed. These measures are most effective where an area has not been extensively developed. Land use controls can be extremely effective in reducing the risk of groundwater contamination by restricting high-risk activities or limiting development densities in sensitive areas. In some cases, it may be feasible to introduce by-laws to restrict or prohibit specified activities within already developed time of travel zones.

The efforts to consider and select microbial contamination control measures for various sources of contamination and land uses should start with general management tools such as public education, public/private partnerships, zoning by-laws, contaminant use restrictions and follow with tools specific to the type of contamination source, i.e., residential, commercial, and agricultural.

5. Monitoring Plans and Contingency Measures

Depending on the intrinsic susceptibility of the aquifer to contamination and the nature of nearby microbial contamination risks, it may be necessary to develop a sentinel monitoring program to ensure that public health and safety is effectively protected. This monitoring program would involve regular monitoring in observation wells established between municipal production well(s) and potential sources of microbial contamination and areas of potential aquifer disturbance.

6. Schedule for Implementation of Microbial Contamination Control Measures

The establishment of a proposed implementation schedule is the last step in the development of a microbial contamination control plan ("proposed wellhead protection measures").

Timely implementation of appropriate microbial contamination control measures for these drinking-water systems is crucial in ensuring continued effectiveness of the *in situ* filtration processes and the overall safety of the supplied drinking water. Therefore, in order for the Microbial Contamination Control Plan (and the proposal not to provide chemically assisted filtration) to be acceptable to the Ministry (Director), the proposed implementation schedule must show that the municipality intends to implement the necessary measures as quickly as reasonably possible.

IV SUBMISSION OF A REPORT TO MOE

Where the microbial contamination control plan has been developed in support of a request for MOE approval not to include chemically assisted filtration step in the water treatment process, the municipality's submission to the MOE must include the following documentation:

- the contamination source inventory list prepared in accordance with this Guidance Document, including the source ranking/categorization,
- a copy of the to-scale WHPA delineation map prepared in accordance with the Delineation Protocol with all existing and potential sources of microbial contamination identified in the inventory list accurately plotted and identified (existing/potential, name and type of source),
- a detailed description of all microbial contamination control measures intended to be taken with references to the specific existing an potential contamination sources identified in the inventory, and
- a proposed schedule for the implementation of the proposed microbial contamination control measures.